What is claimed is:

1. A method for determining an attitude of an accelerating object exclusively from acceleration and angular rate, comprising:

determining an angular rate of the object for conversion into a direction cosine matrix;

determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object;

generating a corrective rate signal based upon the level frame acceleration value; and

updating the direction cosine matrix based upon the determined angular rate of the object and the corrective rate signal to obtain the attitude of the object.

2. The method of claim 1 further comprising:

extracting Euler Angles from the direction cosine matrix to represent the attitude of the object.

3. The method of claim 1 wherein the corrective signal includes a correction component to correct for a heading deviation of the object.

4. The method according to claim 1 further comprising:

performing temperature correction to angular rate and acceleration data to temperature compensate the data which updates the cosine matrix, and to

temperature compensate the corrective rate signal to correct the updated cosine matrix.

5. The method according to claim 1 further comprising:

performing frequency compensation of angular rate data to expand the operational bandwidth of the angular rate data to provide updates to the directional cosine matrix under dynamic conditions which the angular rate data alone would not track, or which compress the bandwidth of the angular rate and acceleration data to reduce noise and to reduce vibration sensitivity in the calculation of the direction cosine matrix.

6. The method of claim 1 wherein the gain of the correction signal is adjustable.

7. The method of claim 1 wherein calibrated data is obtained by applying compensation parameters to the raw sensor data.

8. The method of claim 1 wherein an automated calibration procedure provides the compensation parameters used to compensate the raw sensor data.

9. The method of claim 1 performed with gyros and accelerometers in which the calculation of direction cosine matrix is dependent on the angular rates measured by the gyros, and on the corrective rates determined from an

accelerometer gravity reference algorithm, solved through integration, to normalize the direction cosine matrix.

10. A self-contained system capable of determining an attitude of an accelerating object exclusively from acceleration and angular rate, the system, comprising:

an acceleration sensor aligned with each of a plurality of orthogonally-oriented axes of rotation of the object for providing an acceleration value;

an angular rate sensor aligned with each of the plurality of orthogonally-oriented axes of rotation of the object for providing an angular rate value;

a processor for receiving the acceleration value from the acceleration sensor and the angular rate value from the angular rate sensor, and for executing a computer program that performs the steps of:

establishing a direction cosine matrix representation of attitude based upon the angular rate value;

determining a level frame acceleration value of the object based upon the direction cosine matrix and the acceleration of the object;

generating a corrective rate signal based upon the level frame acceleration; and

updating the direction cosine matrix representation based upon the angular rate of the object and the corrective rate signal to obtain the attitude

of the object.

11. The system of claim 10 further comprising:

a temperature sensor, coupled to the processor, for providing temperature data to compensate the angular rate sensors and acceleration sensors which provide the update and correction to the update of the direction cosine matrix.

12. The system of claim 10 further comprising:

a magnetic sensor, coupled to the processor, for providing heading data to update the direction cosine matrix.

13. The system of claim 10 further comprising:

a frequency compensation stage for frequency compensating the angular rate sensors and acceleration sensors to provide enhanced dynamic response of, reduce the noise in, and reduce the sensitivity to vibration of the updated direction cosine matrix.

14. The method of claim 1 further comprising:

using a local level-plane predefined maneuvering Kalman Filter algorithm to automatically estimate and provide gyro and accelerometer calibration coefficients.

15. A self-contained system for determining an attitude of an accelerating object exclusively from acceleration and angular rate, the system comprising:

a plurality of acceleration sensors configured to determine an acceleration rate of the accelerating object, each acceleration sensor being aligned with one of a plurality of orthogonally-oriented axes of rotation of the object;

a plurality of angular rate sensors configured to determine the angular rate of the accelerating object, each angular rate sensor being aligned with one of the plurality of orthogonally-oriented axes of rotation of the object;

wherein an initial calibration is performed for the plurality of acceleration sensors and angular rate sensors disposed about the orthogonally-oriented axes of rotation for producing calibration data;

a processor coupled to the acceleration sensors and the angular rate sensors and including a memory for storing calibration data, the processor configured to determine the attitude of the accelerating object by:

converting the acceleration rate and the angular rate in time-sequenced share mode;

using the stored calibration data to calibrate the acceleration rate and angular rate of the accelerating object based upon temperature and misalignment of the plurality of sensors on the object;

computing a direction cosine matrix representation of attitude of the accelerating object based upon the angular rate and a corrective angular rate of the accelerating object;

multiplying the direction cosine matrix with a compensated acceleration rate to obtain a true acceleration of the object without tilt;

generating a corrective rate signal based upon the true acceleration of the object without tilt; and

extracting Euler angles from the direction cosine matrix for producing a representative output.

16. The system of claim 15 further comprising:

a plurality of magnetic sensors coupled to the processor and configured to provide a correction rate for yaw axis acceleration.

17. A method of determining an attitude of an accelerating object exclusively from sensors of acceleration and angular rate, comprising:

performing an initial calibration of the plurality of sensors configured to sense the acceleration rate and the angular rate of an accelerating object;

sensing the acceleration rate and the angular rate of the accelerating object by use of the plurality of sensors;

converting the acceleration rate and the angular rate in time-sequenced share mode;

using stored calibration data to calibrate the acceleration rate and angular rate of the accelerating object based upon temperature and misalignment of the

plurality of sensors on the object;

computing a direction cosine matrix representation of attitude of the accelerating object based upon the angular rate and a corrective angular rate of the accelerating object;

multiplying the direction cosine matrix with a compensated acceleration rate to obtain a true acceleration of the object without tilt;

generating a corrective rate signal based upon the true acceleration of the object without tilt; and

extracting Euler angles from the direction cosine matrix for producing a representative output.

18. A method for determining an attitude of an accelerating object exclusively from acceleration and angular rate, comprising:

determining an angular rate of the object for conversion to a direction cosine matrix;

determining a level frame acceleration value of the object based upon the direction cosine matrix and an acceleration of the object; and

supplying attitude error and rate sensor bias estimates to a Kalman filter operating on the level frame acceleration value as a reference to determine the attitude of the object.

19. The method of claim 18 in which attitude error estimate includes determining:

acceleration magnitude from acceleration information along multiple orientation axes excluding gravity orientation; and

invalidating attitude determination in response to the acceleration magnitude exceeding a selected value as indicative of a dynamic maneuver.

20. The method according to claim 18 in which attitude determination is invalidated in response to yaw rate information exceeding a selected value as indicative of a turn maneuver.

21. The method according to claim 18 including also supplying heading information to the Kalman filter operating on the level frame acceleration value as a reference to determine the attitude of the object.

22. The method according to claim 21 in which heading information includes compass heading data.

23. The method according to claim 21 in which heading information includes magnetometer data.

24. The method according to claim 21 in which heading information includes GPS information.

25. The method according to claim 20 in which yaw rate information supplied to the Kalman filter prior to the indicated turn maneuver is supplied for the duration of the yaw rate information exceeding the selected value.

26. The method according to claim 25 in which the state model noise covariance of the Kalman filter is lowered during the acceleration magnitude exceeding the selected value.

27. The method according to claim 25 in which the weighting of the accelerometer attitude reference is lowered in the Kalman filter during the yaw rate information exceeding the selected value.

28. The method according to claim 18 in which the determination of angular rate of an object includes manipulating the object through a predefined set of maneuvers including an initial position as the final position of the maneuvers, and estimating calibration parameters therefrom.

29. The method according to claim 28 in which a Kalman filter calculates the calibration parameters from acceleration and angular rate data from the object as manipulated through the set of maneuvers.